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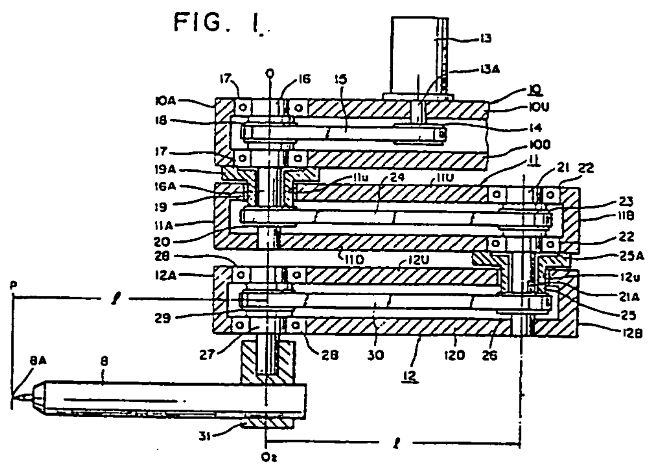
(54) **Offset mechanism for a robot.**

(57) A centre of rotation (0) of a tool (8) in a robot is maintained by means of the mechanism. First and second arms (11, 12) convey movement between a frame (10) and a tool holder (31). A drive motor (13) moves the tool (8) through pulleys (14, 18, 20, 23, 26, 29) and belts (15, 24, 30). The pulleys (14, 18, 23, 29) are secured to rotary shafts (13A, 16, 21, 27) respectively while the pulleys (20, 26) are secured to stationary shafts (19, 25) secured respectively to the frame (10) and the first arm (11). Thus the tool (8) is kept parallel to the first arm (11).

FIG. 1.

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## Description

# OFFSET MECHANISM FOR A ROBOT

### Technical Field

The invention relates to an offset mechanism using rectangular coordinates and suitable for welding or coating or other work.

### Background Art

Such robots have problems over the movement of a tool from the centre of rotation in use. This is explained in detail below after the Best Mode of performing the invention.

### The Invention

Mechanism according to the invention comprises first and second arms for conveying movement from a frame or drive motor to a tool. Shafts connect the frame arms and tool holder. Restraining means, such as belts ensure that in operation the tool is kept parallel to the first arm The restraining means extend preferably between pulleys secured to the shafts. Rotary shafts extend from the motor the frame the first arm, and the second arm and are secured to a pulley and respectively to the first and second arms and to the tool holder. Stationary shafts having pulleys fast thereon are secured to the frame and to the first arm.

### Drawings

Fig. 1 is a longitudinal cross section illustrating a preferred embodiment of the invention;

Fig. 2 is a schematic diagram illustrating the operation in the above embodiment;

Figs. 3 and 4 are side views illustrating a conventional welding robot;

Fig. 5 is a plan view corresponding to Fig. 4;

Fig 6 is a plan view illustrating the problems with the above conventional welding robot; and

Fig. 7 (a) and (b) are perspective views illustrating other problems with the above conventional welding robot.

### Best Mode

In Fig. 1, a frame 10 in square-section tube (for example a Y-axis frame in a welding robot) is connected to a first arm 11, and that in turn is connected to a second arm 12. The frame 10 and arms 11, 12 are parallel, and the edges of the tubes true. A θ-axis drive motor 13 is fixed on the top of the frame 10 some distance away from a closed end 10A, with a pulley 14 mounted at the lower end of a rotary shaft 13A.

A stepped rotary drive shaft 16 adjacent the closed end 10A of the frame 10 is connected to the rotary shaft 13A through a belt 15. The shaft 16 is rotatably secured through bearings 17 in an upper 10U and a lower plate 10D in the frame 10. A pulley 18 is secured to the shaft 16, and a belt 15 is stretched over the pulleys 18 and 14. The shaft 16 has a slender extension 16A protruding from the lower plate 10D and extending to a lower plate 11D of the arm 11 to be connected non-rotatably therewith. The extension 16A penetrates with a clearance through a first stationary shaft 19 which goes through with a clearance a hole 11u in the neighborhood of a closed end 11A of an upper plate 11U of the arm 11. The shaft 19 is hollow, and has a mounting flange 19A which is forced against the lower plate 10D and is bolted thereto (not shown), extending into and terminating in the arm 11 with a pulley 20 mounted at the lower end.

Adjacent an opposite closed end 11B of the arm 11, a first support shaft 21 is rotatably secured by bearings 22 in the upper 11U and lower plate 11D of the arm 11. A pulley 23 is secured to the shaft 21, and a belt 24 is stretched over the pulleys 23 and 20. The first support shaft 21 like the rotary drive shaft 16 has a slender extension 21A protruding from the lower plate 11D and connected non-rotatably to a lower plate 12D. The extension 21A extends with clearance through a second stationary shaft 25 which goes through with clearance a hole 12u in the neighborhood of a closed end 12B of an upper plate 12U in the arm 12. The shaft 25 is hollow and has a mounting flange 25A which is forced against the lower plate 11D and bolted thereto (not shown), extending into and terminating in the arm 12 with a pulley 26 secured at the lower end. Adjacent the other closed end 12A of the arm 12, a second support shaft 27 is rotatably secured by bearings 28 in the upper 12U and lower plate 12D in the frame 12. A pulley 29 is secured on the shaft 27. A belt 30 is stretched over the pulley 29 and a pulley 26 on the shaft 25. The shaft 27 has an extension 27A to which is connected a holder 31 supporting a welding torch 8 of a multiple spindle welding robot.

The distance between a rotational centreline O of the shaft 16 and the centre of the first support shaft 21 is equal to the distance l between an axis O of the second support shaft 27 and the axis of the first support shaft 21, and to the distance horizontally between the axis O of the second support shaft 27 and the front end 8A of the welding torch 8.

With reference to Fig. 2, if frame 10, and arms 11, 12 are as indicated by the solid lines, when the motor 13 is driven to turn its rotary shaft 13A through an angle of $\alpha$ in the direction of the arrow, the rotation is transmitted to the rotary drive shaft 16 through the pulley 14, belt 15 and pulley 18 to turn the shaft 16. When the shaft 16 is rotated, the first arm 11 supported at the end of the shaft 16 turns through an angle $\alpha$ around the axis O of the shaft 16.

The welding torch 8 is kept at all times in a position parallel to the arm 11 because the torch is connected to the arm 11 through a checking mechanism for the rotation of the support shaft consisting of torch holder 31, second support shaft 27, pulley 29, belt 30, pulley 26, and second stationary shaft 25 fixed supported on the arm 11. The arm 12 is connected to the frame 10 through a checking mechanism for the rotation of the support shaft 21 consisting of the pulley 23, belt 24, pulley 20, and first stationary shaft 19 fixed on the frame 10 so

that the arm 11 is kept in a position parallel at all times to the frame 10 even when the arm 11 turns. Thus, when the rotary drive shafts 16 rotates, the arm 11 is caused to rotate around the axis O of the shaft 16, the second support shaft 27 turns around a position P at a distance of l from the axis O of the frame 10, and the welding torch 8 turns through an angle equal to the angle of turn $\alpha$ of the arm 11 keeping a position parallel to the arm 11 so that the welding torch 8 turns around the front end 8A of the torch. Though the front end 8A of the torch 8 and the rotational centreline O of the shaft 16 do not coincide, the welding torch turns around the front end 8A of the torch instead of around the rotational centre O of the shaft 16 so that the rotary shaft 16 is the $\theta$-axis of the automatic welding robot;

1. No need arises to make compensation of X-axis and Y-axis coordinates.
2. The possibility of interferences with the work or work-related jig can be reduced without sacrificing the strokes of other axes such as the X-axis or Y-axis.

Prior Art

In Fig. 3 and Fig. 4, a base 1 has a guide in the direction of an X-axis, a frame 2 on a Z-axis on the base 1, guided by the X-axis guide and having a Z-axis guide. A Y-axis frame 3 is supported by a member 4 and movable in the direction of the Y-axis guided by the Z-axis guide. A motor 5 for $\theta$-axis drive is mounted on the Y-axis frame 3 with a rotary shaft ($\theta$-axis) 6 in the direction of the Z-axis. The shaft 6 protrudes downwards from the bottom of the Y-axis frame 3, and fixedly supports a torch holder 7. A welding torch 8 is supported horizontally by the torch holder 7.

Fig. 3 shows how the location of a front end 8A of the torch (welding point) is shifted a horizontal distance l from a centreline ($\theta$-axis) O of the rotation of the rotary shaft 6. Fig. 4 shows how the torch 8 is so supported by the torch holder 7 that the location (welding point) of the front end 8A of the torch coincides with rotational centreline ($\theta$-axis) O of the rotary shaft 6.

The drive mechanism of the X-axis, Y-axis and Z-axis and their controls are not shown.

In Fig. 4, the front end 8A of the torch is kept on the rotational centreline O with no change in torch angle (the angle between the torch point and the welding torch apparatus). In Fig. 3, the front end 8A of the torch is the distance l from the rotational centreline O so that the front end 8A of the torch makes a circular motion around the rotational centreline O when the shaft 6 is rotated.

For prevention of shift of the front end 8A of the torch, the conventional method involves the compensation of both and Y-axis coordinates in a direction to offset the shift when the shaft 6 is rotated. Such compensations make the control of the drive and its motions complex: the central processing unit (CPU) performs arithmetic operations whenever compensation is to be made in order to actuate the X-axis and Y-axis drives. This increases the possibility of interference of the unit with the work tool, and limits the motion space within which the welding torch 8 is moved. Thus up to an additional 2 l is required for the X-axis and Y-axis stroke. In Fig. 4, when such work W (width x, depth y) as shown in Fig. 6 is involved, the work W and the jig T interfere with each other as the axis drive locates above the welding point. In Fig. 7 (a) and (b), the axes and the drives interfere with each other.

## Claims

1. An offset mechanism for a centre of rotation of a robot characterised by a farme (10), a rotary drive shaft (16) on the frame (10), a first arm (11) non-rotatably secured to the shaft (16), a first support shaft (21) rotatably secured to the arm (11) and non-rotatably secured to a second arm (12), a second support shaft (27) rotatably secured to the arm (12) and non-rotatably secured to a tool holder (31), and checking means (24, 30) extending respectively between a first shaft (19) secured to the frame (10) and the first support shaft (21) and between a second shaft (25) secured to the arm (11) and the second support shaft (27) for keeping a tool (8) parallel to the first arm (11).

2. An offset mechanism means according to claim 1 in which the checking means (24, 30) comprise belts extending between pulleys (20, 23; 26, 29) secured to the appropriate shafts.

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FIG. 1

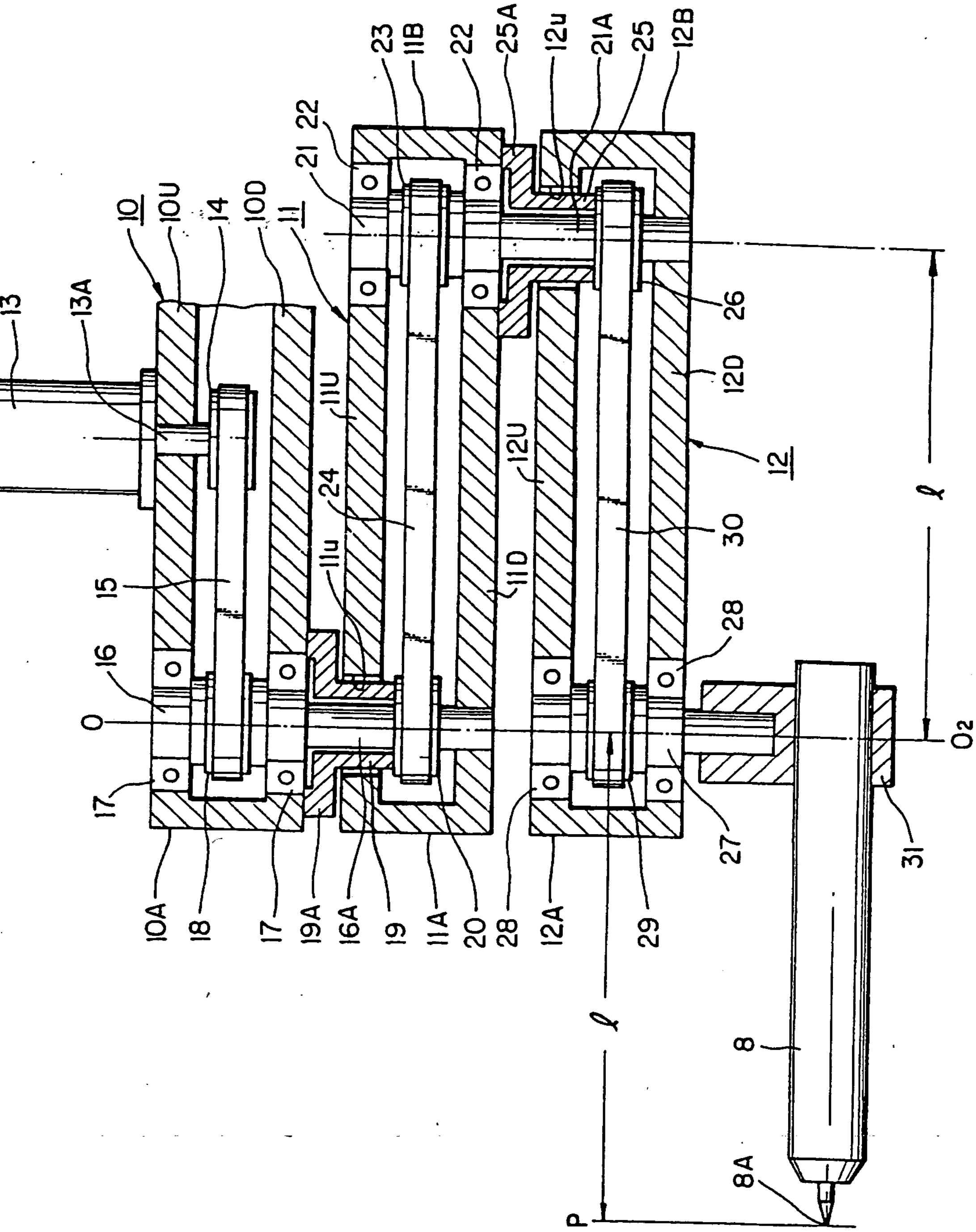

FIG. 2

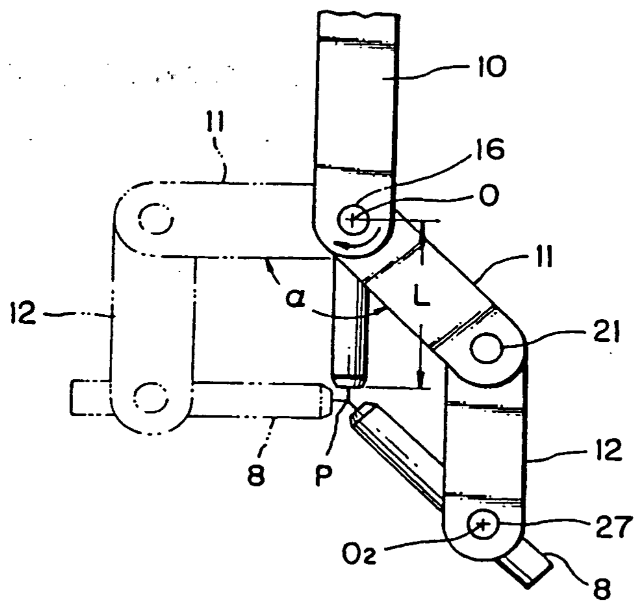


FIG. 3

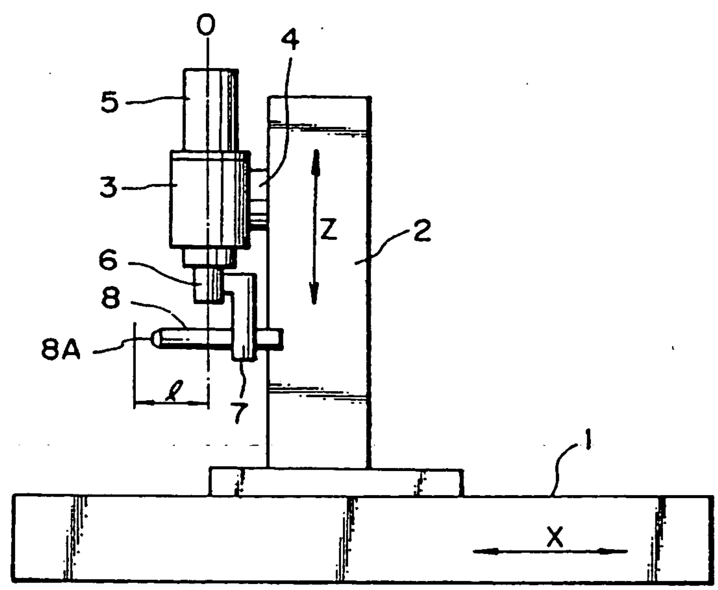

FIG. 4

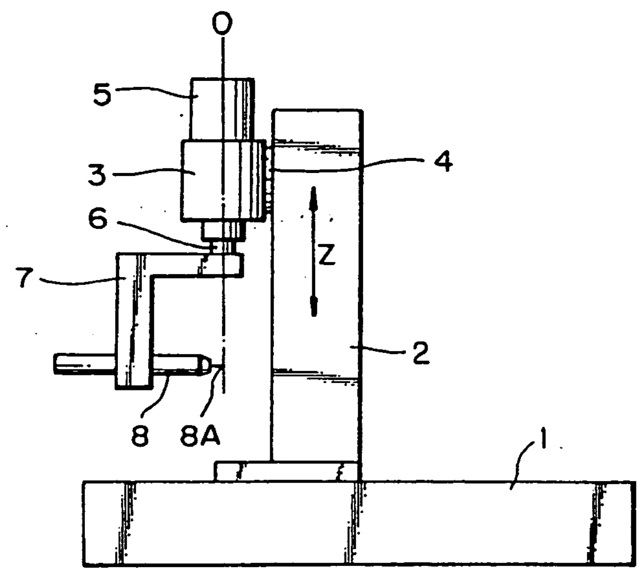


FIG. 5

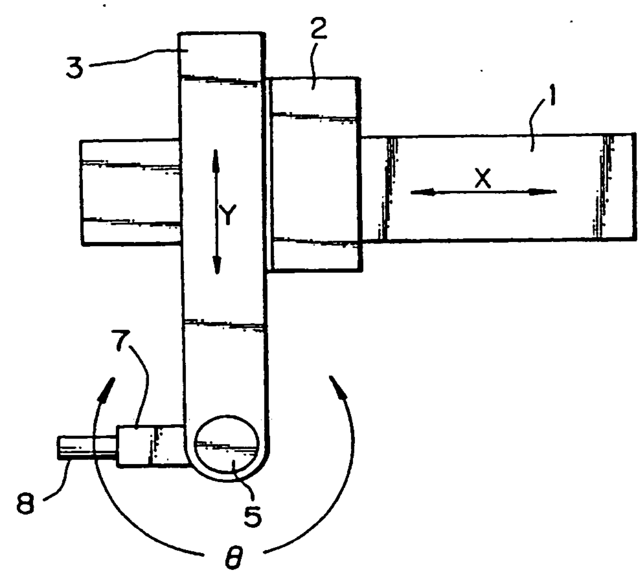

FIG. 6

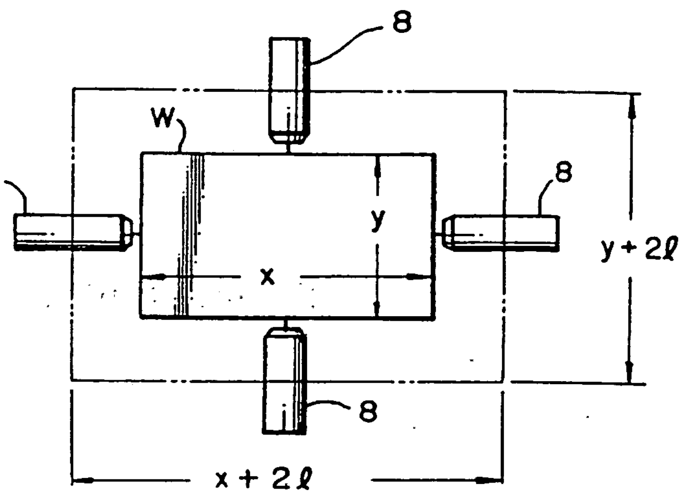


FIG.7(a)

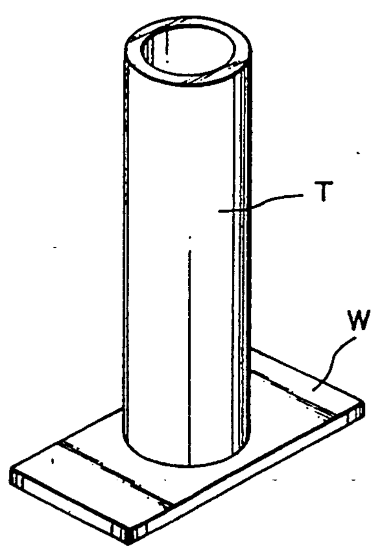


FIG.7(b)